

under those very conditions." This statement, while true in a general way, understates the importance of the point. Notwithstanding the great discrepancies occurring in the general statements made by various writers, I believe it is possible by observing a strictly constant method of experimentation, and by conducting such observations always under the same conditions, to obtain results which may have a very important diagnostic significance. It is not fair to include a number of observations of persons in various conditions of ill-health obtained under different methods of experimentation, and then to say that the electrical resistance of the body varies between so and so. There is a fairly constant degree of electrical resistance for persons in health, and in individuals afflicted with nervous disorders there are wide variations from this standard. While my experiments have been designed to determine the point as regards Graves' disease, I have enlarged them to embrace a number of nervous conditions, with the object of comparing the results, and they serve to emphasise the point that in Graves' disease the body resistance is lowered in a most remarkable manner. It was Charcot who first drew attention to the point, and his remarks made in a clinical lecture¹ were as follows: "The diminution of electrical resistance, inasmuch as it is a symptom at once objective and measurable, is particularly interesting, and may be of great importance in elucidating doubtful cases. If the electrodes of a battery of ten elements are applied, one to the sternum and the other to the back of a healthy subject, a deflection of say thirty degrees of the galvanometer needle occurs, but when the experiment is repeated under the same conditions upon a patient with Basedow's disease, a much greater deflection is found, perhaps up to 90 or 100 degrees. *In every case of this disease examined by M. Vigouroux, this condition has been present*, and he has also found it in certain cardiac affections, notably asystolism."

As to the method of experimentation. A constant cell battery, resistance coil (of 1000 ohms), and galvanometer graduated in milliamperes, and a pair of electrodes are all the apparatus required. The "standard electrodes" recommended by De Watteville should be used, so as to establish uniformity in

¹ *Gazette des Hôpitaux*, 13 and 15, 1886.

the method of examination, and the same spots of the patient's body should always be taken, viz., one electrode on the nape of the neck and the other on the top of the sternum, for the same reason. It is ridiculous to talk of using any number of cells of a battery (though it is often done), for batteries vary in strength from day to day, and it should always be a rule, whatever the current is to be used for, to estimate with the resistance coil and galvanometer the exact strength of the current about to be applied. "Ten, twenty, or forty cells" means nothing; but "5, 10, 20 milliamperes" means a scientific dose. The former is like throwing a jugful of medicine at a patient, the latter like giving him a properly weighed dose. The method of taking the strength of the current is indicated in the following diagram: ¹

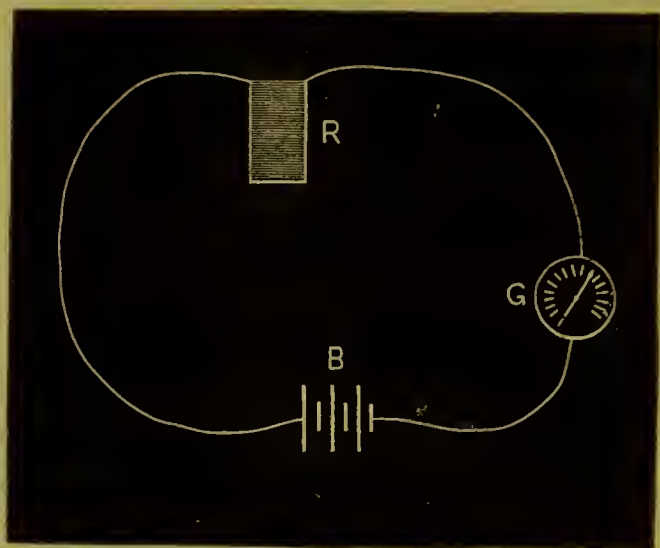


FIG. 1.—R, resistance coil. G, galvanometer. B, constant current battery.

¹ I append here the note of a practical electrician, Mr. J. B. Thisleton, of Old Quebec Street, London, with whom the questions raised in this paper have been the subject of frequent consultation:

"Each Leclanché or sulphate of mercury cell in good working order and freshly charged should give a deflection of at least 1.5 milliamperes, with a total resistance in the circuit of 1000 ohms. The object of using the 1000 ohm coil is to eliminate any errors from a slightly increased internal resistance in any of the cells, which, owing to the large resistance of the human skin, would not affect the passage of the current through it; 1000 ohms is also a very convenient resistance, because with this and a galvanometer divided in milliamperes we are able to see at a glance the electromotive force of any cell, and with any ordinary cell the greater its electromotive force the greater the current that will pass through the body or any other similar resistance to its passage. The electromotive force of a cell is in no way dependent upon its size, and by including a large resistance, such

The method of applying the dose of electricity to the patient is indicated here :

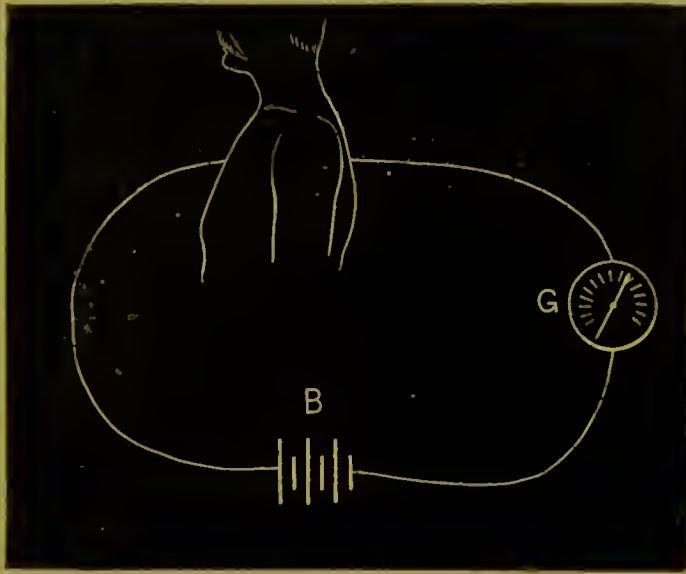


FIG. 2.—Patient with one electrode on the nape of the neck, the other on the top of the sternum. G, galvanometer. B, constant current battery.

If any number of healthy people are examined by the method indicated, it will be found that the body resistance to the passage of a moderate current of 15 volts EMF, will register about 5000 ohms. Occasionally one obtains 4000 ohms, sometimes it is much more than this, but the average may be taken at 4000—5000 ohms. This I have determined on some fifty persons, in health, or with slight throat complaints. One may regard anything approaching 3000 ohms as low, and 2000 ohms as very low, and 1000 ohms as remarkably low resistance. The resistance of the healthy body to the passage of a current of about 15 volts EMF is really very great, and very little passes through the system.

as a patient's body or the 1000 ohm coil, the increased current given by a large cell will not be of any advantage over that given by a small one ; so that, in testing with the 1000 ohm coil or acting upon a patient, it will be at once seen that a large cell gives no more current than the smaller one, owing to the large external resistance. Provided then with a coil of 1000 ohms and a galvanometer showing the current in milliamperes, we are able to test any battery without any calculation, because according to Ohm's law— $C \div R = E$,— C being current, R , resistance and E , electromotive force. Suppose our galvanometer to give a deflection of .0015 ampère (1.5 milliampère) with our resistance coil of 1000 ohms, then $.0015 \times 1000 = 1.5$ EMF in volts, in other words the electromotive force of the current in question is 1.5 volts. Every battery should be tested before application, and the current accurately estimated."

It would occupy too much space to detail all the cases of Graves' disease in which I have estimated the body resistance, and I, moreover, propose to do this at another time; I will merely confine myself here to recording the results, and will detail two cases only out of some five-and-twenty in which I have examined the point.

CASE I.—S.R., aged 49, a warehouseman's wife, dated her illness from three weeks before coming to me. Catamenia had stopped three months before. The thyroid was bilaterally enlarged, soft and pulsatile. Heart acting forcibly; palpitation at times; pulse 168. A very slight degree of exophthalmos, but Graefe's sign absent. Much frontal headache, constant cough, and feeling of faintness and sickness, but no diarrhoea. Sweating of the whole body and feeling of heat. Temperature 100° F. Marked tremor of the limbs. Sleep restless and appetite poor. The patient was very nervous, and had the frightened aspect so characteristic of Graves' disease. Electrical resistance with EMF 15 volts = 300 ohms.

CASE II.—E.A., a shop-assistant aged 19, stated that her illness dated back twelve months, at first marked by swelling of the right lobe of the thyroid. Now there was bilateral swelling, soft and throbbing, slight double exophthalmos, clammy skin, with frequent sweats, very fine tremor, palpitation on exertion, pulse 130, temperature $100\frac{3}{4}^{\circ}$, nervous aspect, and twitching of the muscles of the eyelids. Catamenia regular. Electrical resistance with EMF 13 volts = 200 ohms. A little while after, when the general symptoms had much amended, the resistance had increased to 1000 ohms.

It would occupy too much space to give in detail all the cases observed by me, and I will only therefore record the condition of body resistance in twenty of these patients:

CASE	III.	E. R. =	500 ohms	} All these were cases of Graves' disease in which the disease was well-marked.
	IV.	E. R. =	700 "	
	V.	E. R. =	500 "	
	VI.	E. R. =	800 "	
	VII.	E. R. =	950 "	
	VIII.	E. R. =	700 "	
	IX.	E. R. =	1300 "	
	X.	E. R. =	1200 "	
	XI.	E. R. =	1500 "	
	XII.	E. R. =	1000 "	
	XIII.	E. R. =	1500 "	} In all these cases, the disease was of the undeveloped or "fruste" form; <i>i.e.</i> , there was not always present the triad of well-known symptoms, but always thyroid swelling, palpitation, rapid pulse, and a host of the minor signs, which collectively leave no doubt of the diagnosis.
	XIV.	E. R. =	1000 "	
	XV.	E. R. =	1300 "	
	XVI.	E. R. =	1200 "	
	XVII.	E. R. =	1500 "	
	XVIII.	E. R. =	1200 "	
	XIX.	E. R. =	1400 "	
	XX.	E. R. =	1300 "	

It is evident how low the body resistance is in Graves' disease, and the fact that it is so even in the undeveloped or early forms of this disorder shows how valuable the point is as an aid to diagnosis, and the truth of Charcot's remark that "cases of the undeveloped form would sometimes be very difficult to diagnose, were it not for the palpitation, tremor, and diminution of electrical resistance revealing their true nature." In one such case he found the latter register only 1170 ohms and in another only 900 ohms.

But in order to make the point of diagnostic value, it must be shown how the body resistance is altered in various other forms of disease. First, it assists to a certain diagnosis of the goître of Graves' disease from forms of simple goître. Where one has to rely on a number of minor signs for this purpose, the importance of such an aid can scarcely be overestimated. Cases of goître find their way to the surgeon frequently, in which but little palpitation is complained of, and in which there is no exophthalmos, and the true nature of which is overlooked. Since the treatment is so widely different for the two forms of thyroid swelling, and that designed for the one class of case would often aggravate the other, such an objective sign, so easily obtained, would lead to a true appreciation of the case, or at any rate raise suspicions which would lead the practitioner to seek for a number of the minor signs which are constantly found to occur in Graves' disease but not in simple goître.

In ordinary goître the body resistance is not diminished. In one case I found it to be 5000 ohms, in a second 5000 ohms, in a third 6000 ohms. In other cases I have found it to be never under 5000 ohms. In a case of malignant disease of the thyroid it registered 8000 ohms.

As for other nervous conditions, I examined seven cases of hemiplegia, and found it vary between 1,300 and 4000 ohms. In seven cases of epilepsy it varied between 1000 and 4000 ohms, in three cases of cerebral softening it averaged 3000 ohms, in two cases of paraplegia it averaged 3000 ohms, in one case of general paralysis it stood at 6,500 ohms, in one case of infantile paralysis it was 2,600 ohms, and in a case of hystero-epilepsy 1,600 ohms.

It is thus seen that in epilepsy, and to a lesser degree in hemi-

plegia, the body resistance was in some cases much lowered, and to a lesser degree, perhaps, also in paraplegia and infantile paralysis. In a very bad case of chorea in a man of 37, due to fright, I found it stand at 350 ohms. I examined all these cases, by the kindness of my friend Dr. Scanes Spicer, at the Fulham Infirmary; and had a most striking confirmation of the truth of the statement that body resistance is diminished in Graves' disease in a case which Dr. Spicer showed me, of Graves' disease, of an acute form, occurring in a woman of 66, in whom the symptoms were very severe (thyroid swelling, exophthalmos, great palpitation, and rapid pulse at 160), and whose electrical resistance to a current strength of 13 volts EMF registered only 250 ohms. The demonstration was very striking when brought into comparison with the cases of nervous diseases I had just previously (the same afternoon) examined, and which are mentioned above.

We might almost say that there is no body resistance at all in many cases of Graves' disease. Why should there be this enormous diminution of skin resistance? It is certainly not due to the moisture of the skin, for it occurs whether the skin be wiped dry and dusted with starch powder or not before the electrodes, also almost dry, be applied. It is not due to errors from use of electrodes of varying sizes, since the same electrodes were used for all cases, and the experiments were always conducted under precisely the same conditions. It is not due to variations in the strength of the current used, since I have almost always used the same, viz. that due to 15 volts. Moreover, the curious fact is noted that in well-marked cases of Graves' disease a deflection of the galvanometer needle may be obtained by using a current strength of only 2—3 volts EMF, a feat which is impossible with any other condition. The "why and wherefore" is not clear; but it is not unlikely that the reason of this diminished resistance in Graves' disease is to be found in the vasomotor dilatation of the skin capillaries, which thus render the skin saturated with fluid, and practically reduce the thickness of the ill-conducting epidermis to a minimum. The practical importance of the point is shown in the fact that its proof can be obtained in the early or "formes frustes" of the disorder; and my observations confirm the statement made by Charcot that diminution of the

electrical body resistance becomes one of the most important signs to be relied upon for diagnosis of these obscure conditions. The skill of the physician is shown in his ability to recognise a condition before it becomes patent even to the most careless observer, and this electrical point will therefore be a most valuable sign. It is moreover so easy of application that any one can make the experiment.

I find that Silva¹ noted that the electrical resistance in three of his cases increased from 1000 to 5,500 ohms, with improvement of the patients under treatment; and this coincides with my own observations, which show that as the patients improve under treatment their body resistance mounts more to the normal standard. I have had the opportunity of demonstrating this point as regards Graves' disease to a number of physicians who have at various times seen my cases, and have derived much assistance from my clinical assistants Dr. Haultain, of Toronto, and Drs. Myles and Breckenridge, in making the observations.

¹ *Gaz. delle Clin.* ii. 16-18, 1885.

CASES ILLUSTRATING THE PRODUCTION OF HIGH BODY-TEMPERATURE IN VARIOUS ANOMALOUS CONDITIONS.¹

BY C. HANDFIELD JONES, M.B. CANTAB., F.R.C.P.

AMONG the many morbid phenomena which are continually meeting our gaze, none are more worthy of attention than the variations in the bodily temperature. Though the increase of heat evident to the thermometer does not constitute the whole of fever, yet it constitutes a great deal; and its motors are very apt to produce analogous effects in other organs. To enquire then what these motors may be, in fact, how high temperature may be produced, seems to be a topic worthy of being brought before such an audience as I now address. You will not, I trust, expect me to introduce to you any striking novelty, but yet I hope to interest you by the relation and consideration of cases which have occurred in actual practice, and are certain to occur again. Some theory I must ask you to permit, but it shall not bear the same proportion to practical matter that Falstaff's sack did to his bread. Let me then first say that I still hold the view which I advocated ten years ago,² viz., that while the actual generation of heat doubtless depends on the combustion of protoplasm, the amount produced is regulated by the nervous system, or more exactly by certain nervous centres probably located in or near the Pons Varolii. This view is that taken by Virchow, and is maintained by Dr. Broadbent in his able article on "Fever" in Dr. Quain's *Dictionary of Medicine*.³ Those who adopt

¹ A lecture delivered before the Metropolitan Branch of the British Medical Association.

² *Medical Times and Gazette* (1887), vol. i. pp. 254, 599.

³ See also Dr. MacAlister's *Gulstonian Lectures* (Macmillan: 1887).

restoration to health, there can be no doubt that the remedy and the recovery stand in the relation of cause and effect—of course I mean when the observation extends over a sufficient number of instances. *D. Wilks - from Practitioner*

Exophthalmic goître or Graves' disease cured by Belladonna.— L.

As this disease is so chronic in its course, and as belladonna so often produces specific symptoms, it is necessary to leave it off for a time, and in the intervals give some other medicine such as quinine. It is thus true that, in nearly all my cases, other medicines have been given besides belladonna. They have, however, by themselves been found quite ineffectual in arresting the disease. I therefore consider that they may be put aside as inert. This leaves the belladonna alone as the sole agent in bringing about a cure. I have in my note-book several cases, mostly of women in whom the symptoms were well-marked, which got absolutely well in the course of some months under the belladonna treatment. I have usually given half a grain of the extract three times a day, with short intervals of rest. I may here remark that it is admitted that the disease may exist notwithstanding the absence of certain symptoms: in one case there may be no exophthalmos, and in another no goître. I go further and believe I see cases where neither exophthalmos nor goître exist. But lately I saw a middle-aged lady who, without apparent cause, had grown very thin, and had taken tonics and good diet without any effect. I observed a very rapid pulse and perspiring skin. I thought of Graves' disease and I prescribed belladonna. When I saw her a month afterwards she was another woman, and on the high road to complete recovery.

Idiopathic anæmia is another disease continually tending downwards to inevitable death, but very often absolutely cured by *arsenic*. Having now used this medicine for nearly thirty years, I am much impressed with its value, and consider it one of the most remarkable in the *Pharmacopœia*. During the last year I was consulted by a gentleman between 50 and 60 years of age, who for several months had been getting so pale and breathless that he was obliged to give up the duties of his profession. He had long taken iron and plenty of animal food in vain. I prescribed solution of arsenic in five-minim doses three times a day. In a month he had colour in his cheeks, and

had recommenced his work. When I met him two months afterwards he said he was quite well. In another case, that of a gentleman who had taken to his bed with œdema of the ankles, the patient was walking up the hills near Hastings a month afterwards. He went abroad and I believe had a relapse and died. The temporary effect of arsenic in nearly all these cases is very striking. Let me remark that to give iron to all patients who are pale is poor practice, for even in chlorosis, where it is the best remedy, and the red corpuscles increase under its use, the disease may often be cured by aperients and good diet.

Tuberculous peritonitis.—This is a disease curable by medical treatment: it might perhaps be more correct to speak of tuberculous disease of the bowels, seeing that it is very difficult to determine the depth of the intestine which is affected. In the recoverable cases the mucous membrane is probably not much involved. We know of the curability of this disease from coming across the remains of it in adults who have suffered from the complaint in their earlier years. Some of the most striking pictures I have seen, of what has appeared a resurrection from the dead, have been presented by this disease. I have before my mind's eye two cases of young girls in private practice, and several others of boys and girls in hospital, who were lying in bed wasted to a shadow, with large, tumid, and painful abdomens, presenting indeed the appearance of persons in the last stage of consumption. To see these patients slowly recover, and present themselves perhaps a year afterwards stout and ruddy, has appeared a most marvellous metamorphosis. I do not know what the most approved and accepted treatment may be, but those I have seen recover have followed a pretty uniform plan. They have had the general treatment of cases of phthisis—good living, milk, wine or beer, cod-liver oil, and tonics, especially quinine. At the same time they have had an active treatment as regards the abdomen—iodide of potassium with or without the quinine—and linimentum hydrargyri rubbed over the abdomen, followed often by the tincture of iodine. Seeing the frequent occurrence of recovery I cannot but think that herein the right method has been adopted.

Dysentery and chronic diarrhœa.—If a patient during several months is suffering from these disorders, and is wasting away